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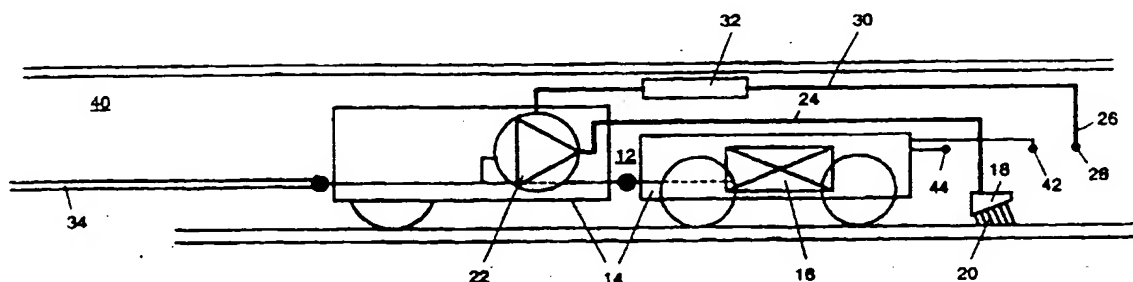
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(54) Title: METHOD FOR INSPECTING PIPELINES, FOR CLEANING PIPELINES, AND APPARATUS FOR CARRYING OUT SUCH METHODS

**(57) Abstract**

The system for cleaning underwater pipelines (8) which are used for conveying oil, gas and/or refining products derived therefrom comprises a vehicle (14) having a motor (16) for driving the vehicle (14), at least one spray head (18) for generating a jet (20) of water and a vehicle pump (22) for feeding water under pressure to the spray head (18). The system further comprises water feed means for feeding water to the vehicle pump (22). The method for cleaning comprises the steps of positioning the vehicle (14) in the pipeline (8), supplying energy to the motor (16) of the vehicle (14), so that the vehicle (14) travels through the pipeline (8), and feeding water and energy to the vehicle pump (22), so that the spray head (18) sprays against at least a part of the inner wall of the pipeline (8) for cleaning the inner wall.

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Title: Method for inspecting pipelines, for cleaning pipelines, and apparatus for carrying out such methods.

The invention relates to a method for inspecting pipelines which are used for conveying oil, gas and/or refining products derived therefrom. The invention further relates to a method for cleaning such pipelines. In addition,
5 the invention relates to a system for carrying out such methods.

Typically, for loading ships, from a refinery on the shore, with oil and/or refining products derived therefrom, use is made of pipelines lying on the seabed. These pipelines
10 connect a so-called 'charge facility' to the processing installation or storage (hereinafter referred to as 'installation') on the shore. It is also known to connect in this manner a tank farm on the shore to a so-called
'discharge facility' in order to transfer the load of oil
15 and/or refining products derived therefrom, contained in a ship, to the tank farm.

The length of such pipelines usually varies from 1-15 km. The walls of these pipelines should be inspected quite regularly to spot corrosion. The purpose of the
20 inspection is to detect and register weak spots in the pipeline so that measures can be taken to prevent leakage.

The inspections of the walls of the fluid-filled pipelines are carried out with apparatus known per se. For this, use is made of ultrasound, inter alia. The reflections
25 of that sound against the wall are detected and analyzed. On the basis of the nature of the reflections, an analysis of the wall can be made and corrosion spots can be detected and quantified.

However, carrying out an inspection is complicated in
30 that the wall is fouled. This is often a paraffin-like substance whose thickness may increase to some centimeters. For a proper measuring by means of ultrasound, however, it is

necessary that the deposit on the wall be not thicker than 1 mm. Also, paraffin-like substance may be present in the corrosion spots. As a consequence, the inspection of the walls of the pipelines cannot be carried out properly.

5 Earlier, it was considered to flush these pipelines with a fluid such as water in order to clean the pipes prior to their inspection. Nevertheless, it turns out that in this manner, pipelines are often not sufficiently cleaned for carrying out a proper inspection. In particular when the
10 diameter of the pipeline increases, at a constant flow rate, the fluid velocity in the pipe will decrease, as a consequence of which the fouling in the pipe is not flushed away.

The object of the invention is to provide a solution to
15 the above-outlined problem. Here, the method can also be used for land pipelines. To this end, according to the invention, the method for inspecting the pipeline comprises the following steps:

- positioning a vehicle in the pipeline, the vehicle
20 comprising a motor for driving the vehicle, at least one spray head for generating a jet of fluid and a vehicle pump for feeding a fluid under pressure to the spray head;
- supplying energy to the motor of the vehicle so that the vehicle travels through the pipeline;
- 25 - feeding the fluid and energy to the vehicle pump so that the spray head sprays against at least a part of the inner wall of the pipeline for cleaning the inner wall; and
- inspecting at least the cleaned portion of the pipelines.

As, according to invention, the inner wall of the
30 pipeline is treated in situ by a high-pressure jet of fluid, this inner wall can be cleaned effectively. This enables a proper inspection of the pipeline. Because the pump is located in the pipe, a jet of fluid of a high pressure can be generated in situ.

35 In the past, it was considered to dispose a pump outside the pipeline, with the fluid delivered by the pump

being fed via a long hose to the location in the pipeline to be cleaned. However, it turns out that in the hose, in particular when this hose is longer than 1 km, a pressure drop occurs of such magnitude that it is no longer possible to adequately clean the pipeline in situ. As, according to the invention, the pump is located in the pipeline, in particular in the proximity of the location in the pipeline to be cleaned, the problem of the pressure drop is solved in accordance with the invention.

10 According to a particular embodiment of the method according to the invention, the vehicle is conveyed through the pipeline when this pipeline is filled with a fluid. Preferably, the vehicle is then conveyed through the pipeline when it is filled with the fluid products present in the pipeline for conveyance, and the fluid products present in the pipeline for conveyance are fed to the vehicle pump for cleaning the inner wall.

20 According to an alternative embodiment, the products present in the pipeline for conveyance are pumped off and a different fluid is fed to the inside of the pipeline. In that case, the vehicle is preferably conveyed through the pipeline when it is filled with the other fluid and the other fluid present in the pipeline is fed to the vehicle pump for cleaning the inner wall.

25 According to these aspects of the invention, fluid is fed to the pump in a particularly simple and efficient manner.

30 According to another variant of the invention, by means of an external pump located outside the pipeline, fluid is fed to the vehicle pump via a flexible feed hose. The pump located in the pipe then acts as a booster pump to ensure the development of a sufficiently powerful jet for cleaning the pipe.

35 According to a highly efficient embodiment of the method according to the invention, the inspection of the pipeline is carried out with means that are at least partly

disposed on the vehicle. In this manner, it would even be possible that the cleaning and the subsequent inspection of the pipeline be performed in one operation.

According to the invention, the system for cleaning pipelines is characterized in that the system comprises a vehicle having a motor for driving the vehicle, at least one spray head for generating a jet of fluid and a vehicle pump for feeding fluid under pressure to the spray head, the system further comprising fluid-feed means for feeding fluid to the vehicle pump.

According to the invention, a method for cleaning pipelines comprises the following steps:

- positioning a vehicle in the pipeline, the vehicle comprising a motor for driving the vehicle, at least one spray head for generating a jet of fluid and a vehicle pump for feeding a fluid under pressure to the spray head;
- supplying energy to the motor of the vehicle so that the vehicle travels through the pipeline; and
- feeding the fluid and energy to the vehicle pump so that the spray head sprays against at least a part of the inner wall of the pipeline for cleaning the inner wall.

The invention will presently be specified with reference to the accompanying drawings. In these drawings:

Fig. 1 shows a pipeline that is to be cleaned;

Fig. 2 schematically shows a first possible embodiment of a system according to the invention for carrying out a method according to the invention;

Fig. 3 schematically shows a cross section of the system according to Figs. 2 and 4; and

Fig. 4 shows a second possible embodiment of a pipeline that is to be cleaned.

In Fig. 1, reference numeral 1 designates a storage or processing apparatus (installation). Further, reference numeral 2 designates a charge facility for loading on site, via a pipe 4, a ship 6 with a refining product from the installation 1. For this purpose, the installation 1 is

connected to the charge facility 2 via an (underwater) pipeline 8. Via the pipeline 8, the refining product is pumped from the installation 1 to the charge facility 2. The ship 6 can be loaded on site at the charge facility 2. Also
5 when the ship 6 is to be unloaded, a comparable apparatus can be employed. In that case, the facility acts as discharge facility 3, with the refining product being pumped from the ship 6 to the discharge facility 3, and then from the discharge facility 3, via the pipeline 8, to a tank storage
10 place 10.

The pipeline 8 can have a length of, for instance, 1-15 km.

The pipeline 8 is manufactured from steel and hence susceptible to corrosion. In particular, so-called corrosion
15 spots are formed on the inner wall of the pipeline; corrosion may also occur on the outer surface. These corrosion spots may cause a leakage of the pipeline and, accordingly, a fire or an unsafe situation, or entail pollution of the environment. Therefore, it is desired to inspect the
20 pipeline 8 over its full distance for imperfections. The product to be conveyed through the pipeline can remain in the pipe or be replaced by another fluid such as (sea)water. Subsequently, by means of ultrasound and the measuring of reflections of the pipe wall, an analysis of the wall can be
25 carried out.

Fig. 2 shows a system 12 according to the invention for the cleaning and improved inspection of the pipeline 8. The system 12 is for instance introduced into the pipeline 8 at the installation 1. Of course, it is also possible to
30 introduce the system 12 into the pipeline 8 in a different manner. The manner in which the system 12 is introduced into the pipeline 8 is not essential to the invention.

According to a possible embodiment of the system, as shown in Figs. 2 and 3, the system consists of a vehicle 14
35 comprising a motor 16 for driving the vehicle 14. The vehicle further comprises a spray head 18 for delivering a jet of

fluid 20 and a vehicle pump 22 for feeding, under pressure, a fluid to the spray head 18 via conduit 24. The system further comprises fluid-feed means 26 for feeding fluid to the vehicle pump 22. In this example, the fluid-feed means 26
5 comprise at least one suction mouth 28 which is connected, via a conduit 30, to the vehicle pump 22. Here, a filter 32 is further disposed in the conduit 30. In this example, the vehicle pump 22 is an electrically driven pump which, in use, generates a fluid pressure of at least 80 bar. Because in
10 this example, the distance between the vehicle pump 22 and the spray head 18 is small (for instance less than 15 m), no notable pressure drop will occur in the conduit 24, so that this 80 bar is at least almost entirely available at the spray head 18. In this example, the motor 16 is also
15 electrically driven. The system further comprises a flexible, electric cable 34 for supplying electric energy to the motor 16 and the vehicle pump 22 of the vehicle. In this example, the cable 34 extends from the vehicle to the end of the pipeline 8 at the installation 1. In or adjacent the
20 installation 1, in a portion of the pipeline 8 that extends above fluid, an opening has been provided through which the vehicle 14 has been introduced into the pipe 8 and through which the cable 34 extends outside the pipe for supplying energy to this cable 34. The electric cable has a length of
25 at least 1 km and in this example even a length of 15 km to enable the vehicle 14 to run through the entire pipeline 8 to a position near the charge facility 2. Because the fouling of the pipe is particularly located in a bottom portion, indicated in Fig. 3 by the arrow 36, the spray head 18 is at
30 least substantially downwardly directed. As a result, a jet of fluid is generated which is directed substantially downwards and which covers at least an area of the pipeline 8 indicated in Fig. 3 by the arrow 38.

The operation of the system is as follows. As stated,
35 the pipeline 8 is filled with fluid 40. Next, the vehicle 14 is positioned in the pipeline 8. Via the electric cable 34,

energy is supplied to the motor 16 of the vehicle 14, so that the vehicle starts to travel through the pipeline. Also, energy is supplied to the vehicle pump 22. As a result, the vehicle pump 22 will draw in fluid via the suction mouth 28, to subsequently spray this fluid in the form of the jet of fluid 20, via the spray head 18. This will cause the spray head to spray against the above-mentioned portion 38 of the inner wall of the pipeline for cleaning the inner wall. In this manner, at least almost the entire length of pipeline is cleaned while the vehicle travels. In this example, the vehicle will travel through the pipeline over a distance larger than 1 km. After a portion of the inner wall has been cleaned, this portion can be inspected in a manner known per se by means of ultrasound. For this purpose, ultrasound is emitted and the reflections of the pipeline wall are detected and analyzed. From this analysis, known per se, relevant information about the presence of, for instance, corrosion spots in the pipeline 8 can be obtained.

Further, similar means can be disposed on the vehicle 14 to enable checking the effectiveness of the cleaning process. In this example, these means consist of an ultrasonic system and sensor 42. Via the cable 34, the signals generated by the ultrasonic system can for instance be fed to a register means for further processing, which register means is disposed at the installation 1. Because in this example, the vehicle 14 moves from left to right in the drawing, this implies that the means for carrying out the inspection analyze an uncleaned pipeline. Preferably, the means for carrying out the inspection also comprise a second ultrasonic system and a second sensor 44, which are also connected to the vehicle 14. In this case, the second sensor 44 is arranged so that it is located ahead of the vehicle 14, but aft of the spray head 18, and thus analyzes a cleaned pipeline. By processing and comparing, in combination, the information about cleaned and uncleaned spots in a manner known per se, the effectiveness of the

cleaning operation can be determined. In particular, the electric cable 34 has a (selected) specific gravity which at least substantially corresponds to the specific gravity of the predetermined fluid with which the pipeline 8 is filled.

5 This will cause the electric cable 34 to float in the pipeline 8. The floating electric cable 34 has the advantage that it hardly hinders the vehicle during travelling. Indeed, the vehicle does not have to drag the cable 34 across the pipe bottom in such manner that it involves a great friction
10 having to be overcome.

Fig. 4 shows an alternative embodiment of the system according to the invention, in which parts corresponding to Fig. 2 have been provided with the same reference numerals.

According to the particular embodiment of the system as
15 shown in Fig. 4, the fluid-feed means 26 comprise an external pump 46 and a flexible feed hose 48. Here, an outlet 50 of the external pump 46 is connected to an inlet 52 of the vehicle pump 22 via the flexible feed hose 48. Like the electric cable 34, the flexible feed hose 48 has a length of
20 at least 1 km and in this case even a length up to 15 km. The external pump 46 is arranged so as to be separate from the vehicle. In this example, the external pump 46 is disposed outside the pipe 8 at the installation 1. As shown in Fig. 4, by means of a supply source 54, electric energy is supplied
25 to the pump 22 and the motor 16 via the electric cable 34. The operation of the system according to Fig. 4 is as follows.

The possible replacement of the oil and/or refining products derived therefrom, present in the pipeline, by
30 another fluid such as (sea)water.

On the bottom of the pipeline that is completely filled with fluid, a paraffin-like substance may still be present, which substance should be removed to enable an optimum inspection of the wall of the pipeline 8. In a manner
35 entirely comparable with the manner described in relation to Fig. 2, the vehicle 14 is positioned in the pipeline 8. By

means of the power supply 54, electric energy is supplied to the pump 22 and the motor 16. At the same time, by means of the external pump 46, fluid is fed to the vehicle pump 22. The external pump 46 is for instance a high-pressure pump of 500 bar or more. As the flexible line 48 has a length of about 15 km, a substantial pressure drop will occur over this pipe. The vehicle pump 22 then acts as booster pump to increase the relatively low pressure in the pipe 48 adjacent the vehicle 14 to a desired level of, for instance, 80 bar. Hence, the spray head 18 will again deliver a jet of fluid 20 of the required pressure of, for instance, 80 bar. Hence, the vehicle as shown in Fig. 4 will also start to travel through the pipeline 8 while the substantially downwardly directed spray head 18 generates a jet of fluid 20 which removes the paraffin-like substance that had stayed behind on the bottom of the pipeline 8, to enable a proper inspection of the wall of the pipeline. To the filled flexible pipe 48, it also applies that it has preferably a (selected) specific gravity that is at least substantially equal to the specific gravity of the predetermined fluid with which the pipeline 8 is filled. This has an advantage comparable with the one discussed in relation to the cable 34.

It is emphasized that the invention is by no means limited to the embodiments outlined hereinabove.

For instance, the vehicle 14 can of course also be introduced at the charge facility 2, the discharge facility 3 or at the tank storage place 10. At the same positions, the external pump 46 and the power supply 54 can be disposed, if so desired. Also, at this position, for performing the method according to Fig. 2, the fluid can be fed to the pipe 8 so that it can be drawn in by the pump 22 via the suction mouth 28. After the cleaning of the pipeline 8, the inspection of the pipeline can of course also be carried out with a different vehicle. In that case, in the vehicle 14 according to Figs. 2 and 4, the sensors 42 and 44 for carrying out the cleaning inspection may be omitted. Also, instead of one

spray head, a number of spray heads can be used for cleaning the pipe. Also, the spray head 18 may be designed for rotation in a known manner in order to clean for instance the inner wall along its entire circumference or a part thereof.

- 5 Alternatively, the spray head may be designed as an annular stationary and/or oscillating multi-spray head. The motor may also be for instance a hydromotor. The vehicle may be of a sectional as well as non-sectional construction. Moreover, other means for inspecting the inner wall of the (underwater)
10 pipeline may be applied. The invention may also be applied to underground and aboveground land pipelines.

Such variants are all understood to fall within the framework of the invention.

Claims

1. A method for cleaning pipelines which are used for conveying fluid products such as oil, gas and/or refining products derived therefrom, comprising:
 - positioning a vehicle in the pipeline, the vehicle
 - 5 comprising a motor for driving the vehicle, at least one spray head for generating a jet of fluid and a vehicle pump for feeding a fluid under pressure to the spray head;
 - supplying energy to the motor of the vehicle so that the vehicle travels through the pipeline; and
 - 10 - feeding the fluid and energy to the vehicle pump so that the spray head sprays against at least a part of the inner wall of the pipeline for cleaning the inner wall.
2. A method according to claim 1, characterized in that the pipeline can also be inspected prior to the cleaning
- 15 operation.
3. A method for inspecting, by means of for instance reflections of sound, pipelines that are used for conveying fluid products such as oil, gas and/or refining products derived therefrom, comprising:
 - 20 - positioning a vehicle in the pipeline, the vehicle comprising a motor for driving the vehicle, at least one spray head for generating a jet of fluid and a vehicle pump for feeding a fluid under pressure to the spray head;
 - supplying energy to the motor of the vehicle so that the
 - 25 vehicle travels through the pipeline;
 - feeding the fluid and energy to the vehicle pump so that the spray head sprays against at least a part of the inner wall of the pipeline for cleaning the inner wall; and
 - inspecting at least the cleaned portion of the pipelines.
- 30 4. A method according to claim 1, 2 or 3, characterized in that the vehicle is conveyed through the pipeline when said pipeline is filled with a fluid.

5. A method according to claim 4, characterized in that the vehicle is conveyed through the pipeline when said pipeline is filled with the fluid products present in the pipeline for conveyance.
- 5 6. A method according to any one of the preceding claims, characterized in that the fluid products present in the pipeline for conveyance are fed to the vehicle pump for cleaning the inner wall.
7. A method according to any one of claims 1-4,
10 characterized in that the products present in the pipeline for conveyance are pumped off and that another fluid is fed to the inside of the pipeline.
8. A method according to claims 4 and 7, characterized in that the vehicle is conveyed through the pipeline when said
15 pipeline is filled with the other fluid.
9. A method according to claim 7 or 8, characterized in that the other fluid present in the pipeline is fed to the vehicle pump for cleaning the inner wall.
10. A method according to claim 6 or 9, characterized in
20 that the vehicle comprises a suction mouth for sucking up, from the pipeline, fluid present in the pipeline, said suction mouth being connected to an inlet of the pump.
11. A method according to any one of claims 1-4,
25 characterized in that the fluid is fed via a flexible feed hose to the vehicle pump by means of an external pump located outside the pipeline.
12. A method according to claim 11, characterized in that a flexible hose is used which is longer than one kilometer.
13. A method according to any one of the preceding claims,
30 characterized in that the vehicle is moved through the pipeline over a distance larger than one kilometer.
14. A method according to any one of the preceding claims, characterized in that the vehicle pump generates a fluid pressure of at least 80 bar.
- 35 15. A method according to any one of the preceding claims, characterized in that the at least one spray head is

connected via a conduit to the vehicle pump, wherein the distance between the vehicle pump and the spray head is less than 15 m.

5 16. A method according to any one of the preceding claims, characterized in that via an electric cable, electric energy is supplied to the motor and/or the vehicle pump of the vehicle from a position outside the pipeline.

10 17. A method according to claim 16, characterized in that an electric cable is used having a length of at least one kilometer.

18. A method according to any one of the preceding claims, characterized in that at least a bottom portion of the pipeline is cleaned with the jet of fluid.

15 19. A method according to claim 1 or 2, characterized in that the inspection of the pipeline is carried out with means that are at least partly disposed on the vehicle.

20 20. A method according to claims 4 and 15, characterized in that the electric cable has a specific gravity which is at least substantially equal to the specific gravity of the fluid with which the pipeline is filled.

21. A method according to claims 11 and 15, characterized in that the flexible feed hose has a specific gravity which is at least substantially equal to the specific gravity of the fluid with which the pipeline is filled.

25 22. A system for cleaning pipelines which are used for conveying products such as oil and/or refining products derived therefrom, comprising a vehicle having a motor for driving the vehicle, at least one spray head for generating a jet of fluid, and a vehicle pump for feeding fluid under
30 pressure to the spray head, wherein the system further comprises fluid-feed means for feeding fluid to the vehicle pump.

35 23. A system according to claim 22, characterized in that the fluid-feed means comprise an external pump and a flexible feed hose, wherein an outlet of the external pump is connected to an inlet of the vehicle pump via the flexible

hose and wherein the external pump is disposed so as to be loose from the vehicle.

24. A system according to claim 23, characterized in that the flexible feed hose has a length of at least one
5 kilometer.

25. A system according to claim 22, characterized in that the fluid-feed means comprise at least one suction mouth which is connected to an inlet of the vehicle pump via a conduit, wherein the suction mouth is mounted on the vehicle
10 for sucking up fluid present in the pipeline.

26. A system according to any one of preceding claims 22-25, characterized in that the distance between the vehicle pump and the spray head is less than 15 m.

27. A system according to any one of preceding claims 22-26, characterized in that the vehicle pump is of a type which, in
15 use, generates a fluid pressure of at least 80 bar.

28. A system according to any one of preceding claims 22-27, characterized in that the motor is an electromotor.

29. A system according to any one of preceding claims 22-28, characterized in that the system further comprises a flexible
20 electric cable for supplying electric energy to the motor and/or the vehicle pump of the vehicle.

30. A system according to claim 29, characterized in that the electric cable has a length of at least one kilometer.

31. A system according to any one of preceding claims 22-30, characterized in that the spray head is directed at least
25 substantially downwards.

32. A system according to any one of preceding claims 22-31, characterized in that the vehicle further comprises means for
30 inspecting the pipeline by means of sound.

33. A system according to claim 29, characterized in that the specific gravity of the electric cable is chosen to be at least substantially equal to the specific gravity of the
predetermined fluid with which the pipeline to be cleaned by
35 the system is filled.

34. A system according to claim 23, characterized in that the specific gravity of the flexible feed hose is chosen to be at least substantially equal to the specific gravity of the predetermined fluid with which the pipeline to be cleaned
5 by the system is filled.

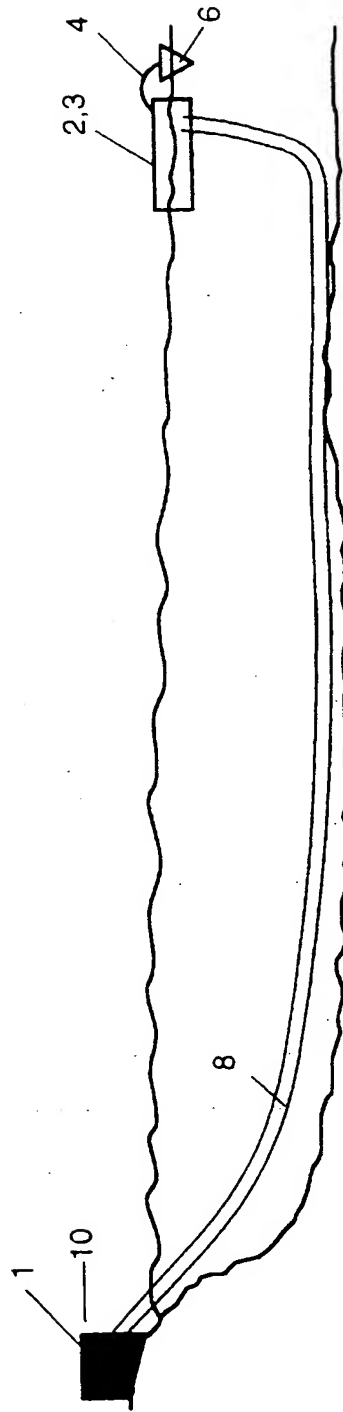


FIG. 1

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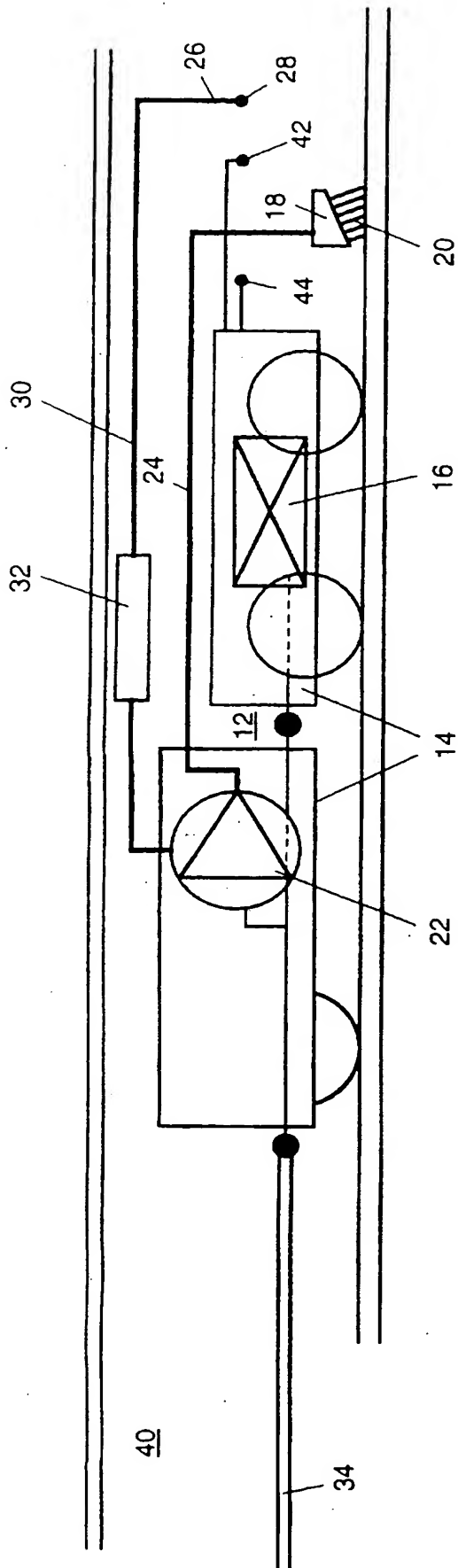


FIG. 2

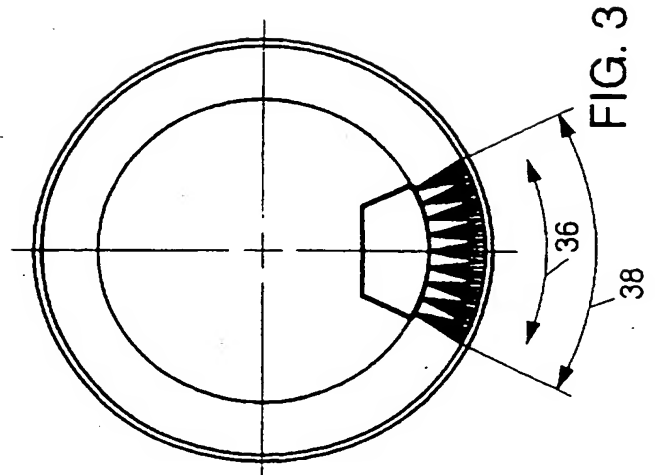


FIG. 3

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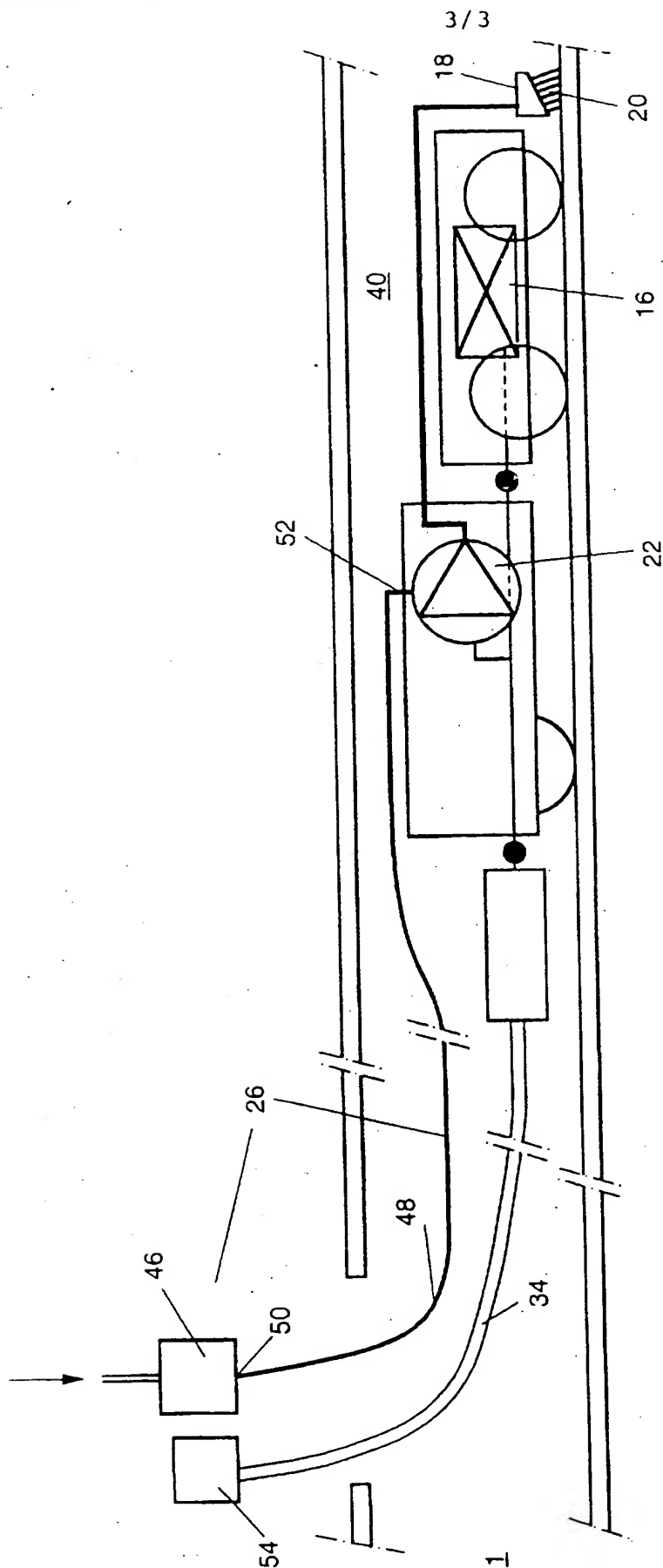


FIG. 4

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